ERDC
Engineer Research and Development Center

Lock Closure Data from LPMS and Districts

LRD Maintenance Workshop

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Structural Health Monitoring

1.0 PURPOSE. This effort will create an integrated, affordable real-time navigation lock gate monitoring system to aid the lock operator in identifying adverse lock conditions before they cause a catastrophic failure.

Structural Health Monitoring

SubTask – Determine what has historically led to unscheduled and emergency closures so we can better understand what are the major issues and develop methods that identify and address causes of unscheduled closures

Collect and evaluate data from LPMS, Divisions, and Districts on unscheduled closures and repairs locks in order to identify what fails and how structural health monitoring can assist in maintaining reliability of infrastructure and avoiding catastrophic failures.

- LPMS closures 2007-2012
- Infrastructure Emergency Closures, 1999–2005 (HQ Navigation Branch)
- EP 1130-2-520, Chapter 2 Special Reports
- Lock log books, FEM data
- Appendix E Scheduled Work vs Work Performed, 2005–2010 (LRD)
- District responses to queries
- **I'm looking for additional unscheduled and emergency closures data sources**

Lock Closure Data
LPMS

- Location (EROC, River code, Lock #)
- Begin stop date/time
- End stop date/time
- Scheduled (Y/N)
- Reason code

LPMS includes no details on what failed or how

Details:
- What component,
- What happened to the component,
- How it was discovered, and
- How it impacted gate operation

LPMS Data

eroc	EROC river	RIVER CODE	project name	LOCK NO	CHMBR NO	BEG STOP DATE	END STOP DATE	days	SCHEDULED	REASON CODE
LRH	H1	OH	Belleville Lock & Dam	21	4	6/28/2009 23:29	6/30/2009 23:59	2.02	N	T
LRH	H1	OH	Belleville Lock & Dam	21	4	2/27/2010 20:20	2/28/2010 23:59	1.15	N	EE
LRH	H1	OH	Capt. Anthony Meldahl Lock & Dam	25	2	9/20/2010 6:55	9/24/2010 18:55	4.50	N	T
LRH	H1	OH	Capt. Anthony Meldahl Lock & Dam	25	4	1/8/2008 9:00	1/12/2008 8:53	4.00	N	T
LRH	H1	OH	Capt. Anthony Meldahl Lock & Dam	25	4	8/18/2008 8:26	8/20/2008 11:20	2.12	N	T
LRH	H1	OH	Capt. Anthony Meldahl Lock & Dam	25	4	9/1/2010 0:00	9/20/2010 8:23	19.35	N	T
LRH	H1	OH	Capt. Anthony Meldahl Lock & Dam	25	4	2/17/2011 10:30	2/28/2011 23:59	11.56	N	T
LRH	H1	OH	Capt. Anthony Meldahl Lock & Dam	25	4	3/1/2011 0:00	4/3/2011 20:19	33.85	N	T
LRH	H1	OH	Greenup Lock & Dam	24	2	12/1/2009 23:59	12/4/2009 18:00	2.75	N	T
LRH	H1	OH	Greenup Lock & Dam	24	2	1/27/2010 14:44	1/30/2010 19:52	3.21	N	R
LRH	H1	OH	Greenup Lock & Dam	24	2	1/30/2010 20:45	1/31/2010 23:59	1.13	N	T
LRH	H1	OH	Greenup Lock & Dam	24	4	12/14/2007 11:00	12/28/2007 3:00	13.67	N	O
LRH	H1	OH	Greenup Lock & Dam	24	4	5/6/2008 8:30	5/7/2008 16:00	1.31	N	T

Lock Closure Data
LPMS Reasons

- LPMS includes 34 closures reasons in 6 different categories
  - Weather Conditions
  - Surface Conditions
  - Tow Conditions
  - Lock Conditions
  - Other Conditions
  - Unknown

Lock Closure Data
LPMS Reasons

Lock Conditions

- AA – Accident or collision in lock
- BB – Closed (unmanned shift)
- **EE – Repairing lock or lock hardware**
- Q – Debris in lock recess or lock chamber
- **R – Lock hardware or equipment malfunction**
- M – Tow staff occupied with other duties
- **T – Maintaining lock or lock equipment**
- U – Ice on lock or lock equipment
- **Y – Inspection or testing lock**

Lock Closure Data
Emergency Closures

HQ Navigation branch compiled data from 1999 – 2005

- District, **Project**, Year opened, **Closure month-yr, Closure length days, Reason for Closure**, Funding, Cost of Repairs, Impact of Closure, Remarks

INFRASTRUCTURE EMERGENCY CLOSURES (1999 - 2005)

MSC/DIV/MVR	PROJECT	YEAR OPENED	CLOSURE MO - YR	CLOSURE LENGTH DAYS	REASON FOR CLOSURE	FUNDING	COST OF REPAIRS	IMPACT OF CLOSURE	REMARKS
	Illinois Waterway								
1	Marseilles L&D	1933	Jul-99	1.6	Miter gate pintle ball shim	O&M	$66,000	29 tows waiting - longest waited 2 days	Upstream River Gate was misaligned at gate closure.
2	Lagrange L&D	1939	Jan-02	2	Gate anchor broke	O&M	$70,000	40 tows waiting	Gate anchor was on the lower landwall miter gate. Cu
3	Lagrange L&D	1939	Mar-02	16	New miter gate anchors	O&M	$37,000	44 tows waiting	New miter gate anchors were installed during 8 2-day
4	Lagrange L&D	1939	Dec-02	1	Miter gate gudgeon loose	O&M	$16,000	8 tows waiting	Gudgeon pin in lower land wall miter gate worked its
5	Lagrange L&D	1939	Jan-03	1.2	Bull gear gate arm broke	O&M	$13,000	10 tows waiting	Bull gear gate arm on lowe miter gate broke
6	Starved Rock L&D	1933	Feb-04	1	Buffer box on miter gate broke	O&M	$17,000	6 tows waiting	Buffer box broke and plunger bolt sheared off. Main
				22.8			$219,000		
	Mississippi River								
7	L&D 21	1938	Feb-99	7	Repaired #1 and #3 miter gates	O&M	$311,300	Minimal due to scheduled closure timing	Closure was during normal winter slow period - howe
8	L&D 11	1937	Jul-99	1	Replaced failed strut arm on #2 miter gate	O&M	$40,500		
9	L&D 22	1938	Jan-00	47	Replaced machinery bases & elec cables; repaired gea	O&M	$1,201,200	Minimal due to scheduled closure timing	Closure was during normal winter slow period - howe
10	L&D 21	1938	Jan-00	60	Installed bubbler system & replaced damaged seals	O&M	$2,700,000	Minimal due to scheduled closure timing	Closure was during normal winter slow period - howe
11	L&D 13	1957	Jan-01	59	Repaired lower miter gates	O&M	$2,648,800	Minimal due to scheduled closure timing	Closure was during normal winter slow period - howe
12	L&D 11	1937	Apr-01	28	Flood of 2001 - Repaired damage caused by flood	O&M	$436,200		Closure period includes time of flooding when lock no
13	L&D 12	1939	Apr-01	31	Flood of 2001 - Repaired damage caused by flood	O&M	$785,400		Closure period includes time of flooding when lock no
14	L&D 13	1938	Apr-01	30	Flood of 2001 - Repaired damage caused by flood	O&M	$3,540,000		Closure period includes time of flooding when lock no
15	Ls&D 14	1922/1939	Apr-01	27	Flood of 2001 - Repaired damage caused by flood	O&M	$521,400		Closure period includes time of flooding when lock no
16	Ls&D 15	1934	Apr-01	24	Flood of 2001 - Repaired damage caused by flood	O&M	$1,048,200		Closure period includes time of flooding when lock no
17	L&D 16	1937	Apr-01	28	Flood of 2001 - Repaired damage caused by flood	O&M	$1,123,800		Closure period includes time of flooding when lock no
18	L&D 17	1939	Apr-01	28	Flood of 2001 - Repaired damage caused by flood	O&M	$1,146,600		Closure period includes time of flooding when lock no

Lock Closure Data

Accidents and Equipment Failures Reported to HQ Navigation Branch

EP 1130-2-520, Chapter 2 29 Nov 96

2-6. Special Reports.

a. Changes affecting navigation will be made promptly whenever information of immediate concern to navigation becomes known. Refer to ER 1130-2-520 for the circumstances requiring special reports. Items of information especially desired are: (1) _____; (2) _____; (3) _____; (4) _____; (5) _____; **(6) accidents or equipment failures at USACE locks and dams or along navigable waterways, that will result in closure of the lock or waterway for 24 hours or more, or will result in a significant impact to navigation.** For item (6), district commanders are to forward an **incident report** to HQUSACE (CECW-OD) through their MSC office as soon as possible following the incident. Reporting of navigation incidents to CECW-OD is required even though the districts may be sending situation reports to the HQ Emergency Operations Center during natural disasters or more regional or localized events.

Special (Incident) Reports

>>Subject: Inner Harbor Navigation Canal (IHNC) Lock Closed - Damaged Miter
>>
>>INITIAL REPORT: MVD at 0206 hrs 5 Feb 2013
>>
>>BLUF: IHNC Lock in MVN - Gate #8 strut arm failed, but can be repaired
>>first thing this morning after overnight weather front passes. Lock is
>>closed with 29 tows on turn (awaiting transit). Unsafe working conditions
>>prevented MVN staff from repairing immediately.
>>
>>What: IHNC Lock miter gate damaged strut arm, cause of failure unknown,
>>but possibly from over-travel of gate/photo eye issue.
>>
>>When: Monday, 4 FEB 13, ~1900 hrs
>>
>>Where: New Orleans, LA
>>
>>Impacts: some to navigation customers with 29 tows on turn. Industry and
>>USCG have been apprised of the situation. MVN believes the arm can be
>>repaired in-place much faster than a complete swap out as the damage
>>appears to be minimal. MVN does have the spare arm ready to go if needed,
>>and Operations Division teams are ready to respond at daybreak. Poor
>>weather conditions made it unsafe to address Monday night.

FEM Maintenance Records

Failure Data

- Failure class
- Problem
- Cause
- Remedy

Lock Closure Data
LRD Repair Records

LRD repair records

Appendix E - Scheduled Work vs. Work Performed

Repair/Maintenance Schedule for 2005

Scheduled and Performed
Scheduled but Not Performed
Performed but Not Scheduled

River Mile	Project	Repairs	Dates	Remarks
Green River System				
9.1	Lock and Dam 1 (Louisville District)	Sill repairs & dewatering	Aug 10 – Aug 27, 2005	Lock closed, no auxiliary lock
Kanawha River System				
82.2	London L&D (Huntington District)	Roller Gate Bottom Seal Mod Main Chamber Lower Gate Seal Repair/Mod Main Chamber Top Anchorage Adj/Repairs	May 23 – Jul 1, 2005	Main Lock Closed
67.7	Marmet L&D (Huntington District)	Roller gate Chain Repair/Replacement	Concurrent (14 days)	No Delays
31.1	Winfield Lock and Dam (Huntington District)	Aux Lock Repairs (Old Land Chamber Lower Gates)	Jul 4 – Jul 29, 2005	No Delays
Ohio River System				
6.2	Emsworth L&D (Pittsburgh District)	Repair Dam Gates 3 & 11	Feb 22 – Mar 12, 2005	No Delays

Unscheduled Lock Closure Data
infrastructure issues and barge impacts

Data needed:

- Location (EROC, River code, Lock #)
- Begin stop date/time
- End stop date/time

- What component,
- What happened to the component,
- How it was discovered, and
- How it impacted gate operation

Scheduled and Unscheduled Closures

LPMS allows users to record whether a closure is scheduled on unscheduled.

• LPMS offers insufficient guidance on how to determine whether a closure is scheduled or unscheduled.

Scheduled - Scheduled stoppages are announced via Navigation Notices (via mail, email, web posting or bulletin board), Broadcasts to Mariners etc. or should be something that is performed regularly.

Unscheduled - Stoppages must be either scheduled or unscheduled. Unscheduled stoppages are events that force navigation to cease and are not planned.

Asset Management MMIP
Unscheduled Maintenance – Unscheduled maintenance work, usually due to a breakdown of a critical asset/component.

Scheduled and Unscheduled Closures

- Indistinct definitions in LPMS manual
- Chief of navigation (CECW-CO-D) is not aware of any official definition of scheduled and unscheduled closure. (Nov 2013)
- Former Chief of navigation (CECW-CO-D) recalled 72-hour advance notice but noted industry was not fully supportive of this timeframe (Jan 2014)
- Missing IMTS guidance may have said one month notice via Navigation Notices
- Tracey Keel said LRL considers any summer season closure not scheduled by April/May to be unscheduled.
- Bill Frechione said that LRP schedules closures for inspections/repair work about two years in advance. “To me any closure with a lead time too small to allow shippers time to adjust is an unscheduled closure.”

USACE Navigation High Priority Performance Goals

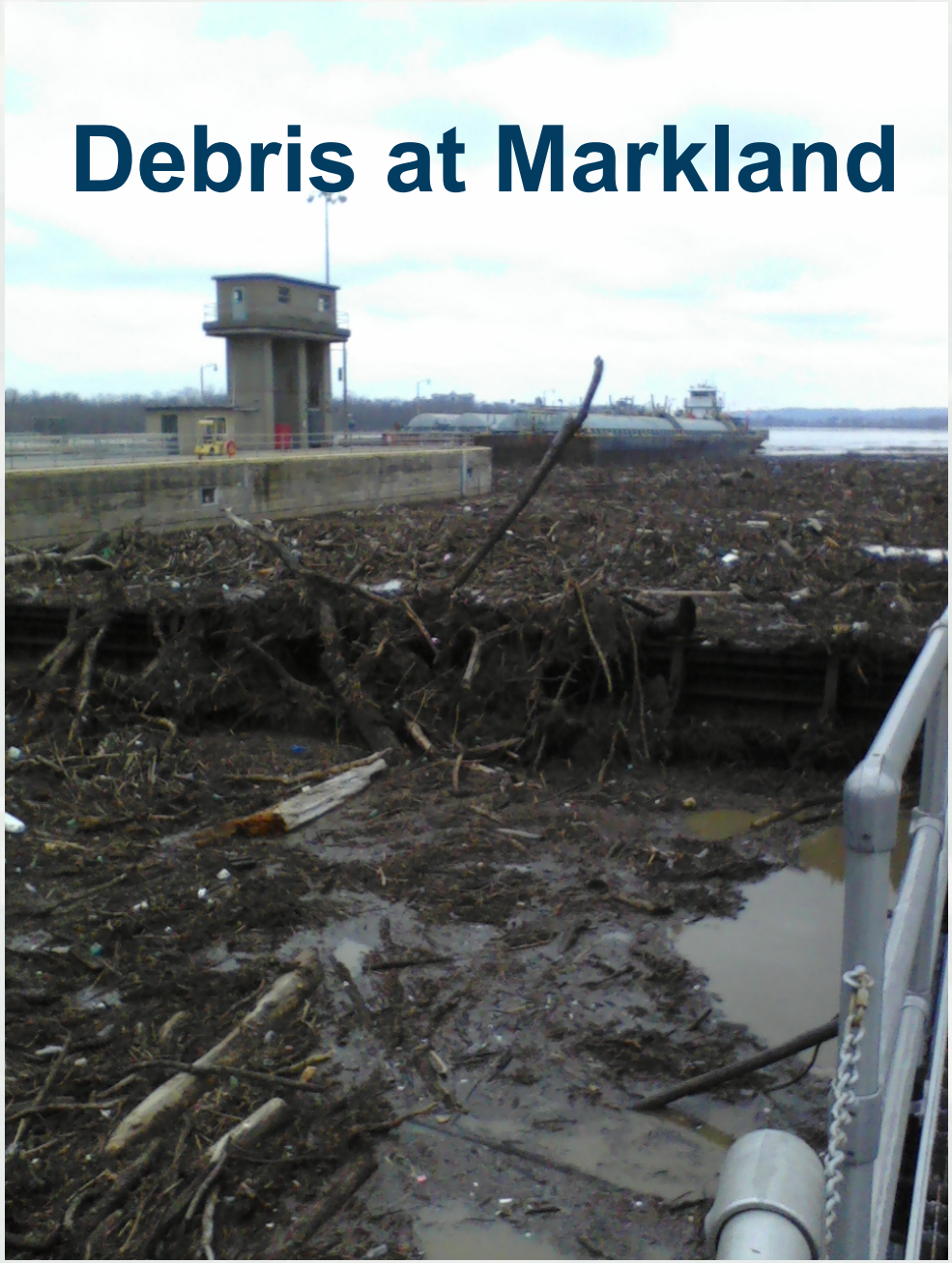
According to the **USACE CW Program Five-Year Development Plan, FY 2011 to FY 2015**, the only high priority performance goals in navigation are lock closures due to mechanical failures lasting more than 24 hours and 7 days.

- Mechanical failures are determined based on data in LPMS

Mechanical Failures
(LPMS reason codes)

List A (HQ)		List B (IWR)
EE - Repairing lock or lock hardware	=	repairing lock or lock hardware
Q - Debris in lock recess or lock chamber	=	debris in lock recess or lock chamber
R - Lock hardware or equipment malfunction	=	lock hardware or equipment malfunction
S - Lock staff occupied with other duties	=	lock staff occupied with other duties
T - Maintaining lock or lock equipment	=	maintaining lock or lock equipment
U - Ice on lock or lock equipment	=	ice on lock or lock equipment
V - Tow detained by Coast Guard or Corps	≠	**Y (y)** inspection or testing

Debris at Markland



Debris at Markland

Department of the Army
U.S. Army Corps of Engineers Civil Works Program
Five-Year Development Plan
Fiscal Year 2011 to Fiscal Year 2015

Fiscal Year	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Actual Instances of Lock Closures due to Mechanical Failures Lasting Longer than 24 Hours	45	45	36	19	33	38	42	37	61	NA
Total Hours for Lock Closures due to Mechanical Failures Lasting Longer than 24 Hours	13,448	12,575	9,265	5,029	9,817	9,317	16,033	11,096	19,562	NA
Actual Instances of Lock Closures due to Mechanical Failures Lasting Longer than 7 Days	25	27	19	13	21	18	28	19	37	NA
Total Hours for Lock Closures due to Mechanical Failures Lasting Longer than 7 Days	12,255	11,399	7,929	4,728	8,871	7,805	15,073	9,675	17,638	NA

Navigation Performance

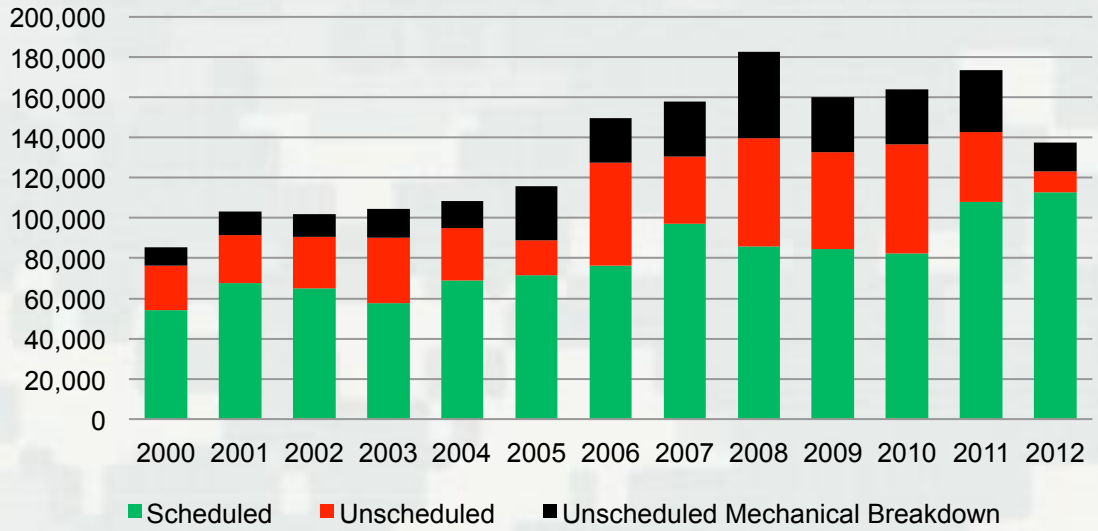
USACE Campaign Goal Objective 3c:

Deliver reliable infrastructure using a risk-informed asset management strategy

High Priority Goal:

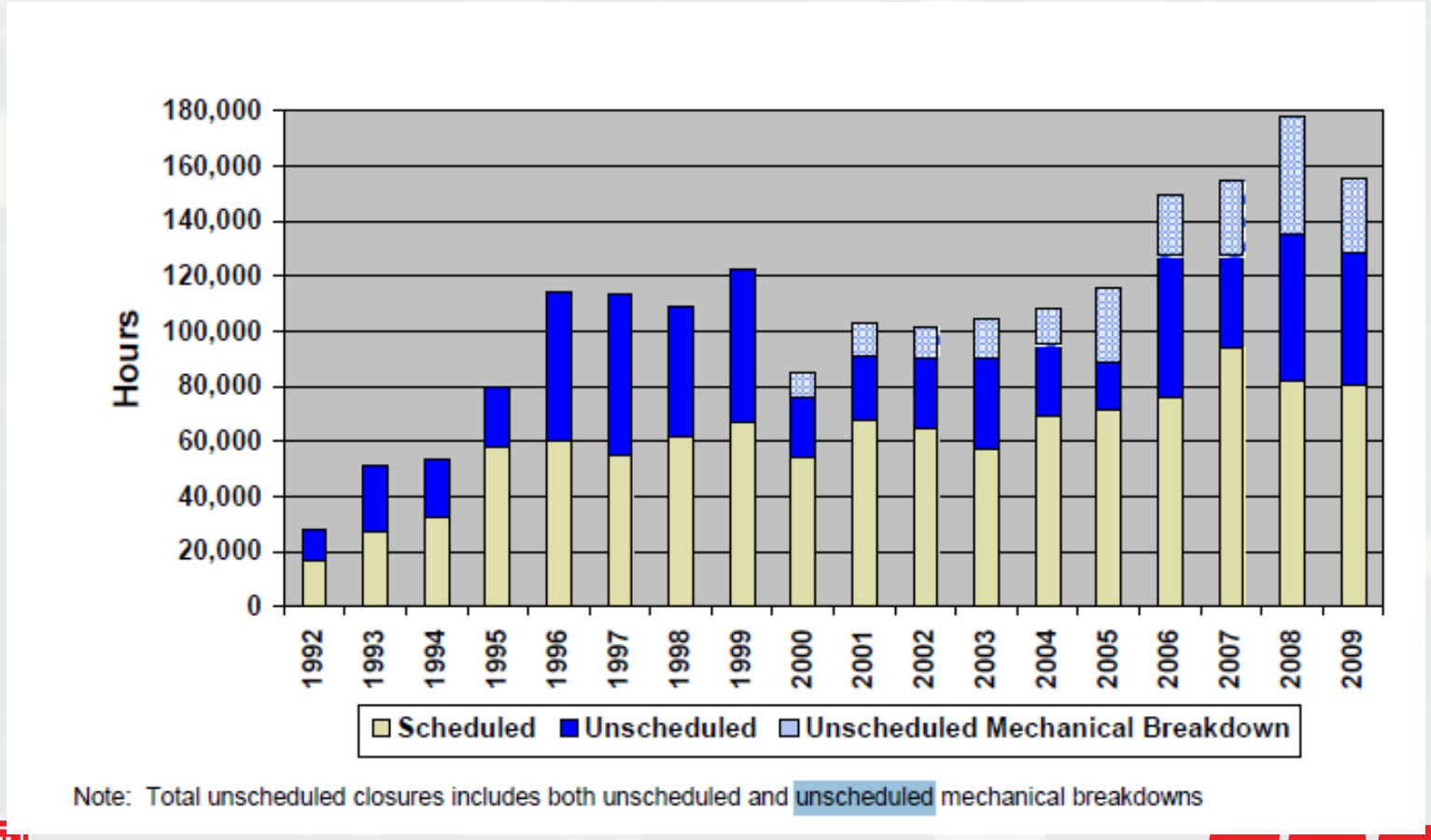
INLAND NAVIGATION:

Scheduled & Unscheduled lock closures due to mechanical breakdowns lasting longer than 1 day and 7 days



Navigation Performance

IMTS Capital Projects Business Model report (2010)



Note: Total unscheduled closures includes both unscheduled and unscheduled mechanical breakdowns

LPMS Reason Codes

Surface Conditions
- O - Debris

Lock Conditions
- Q - Debris in lock recess or lock chamber

Tow Conditions
- P – Tow accident or collision

Lock Conditions
- AA – Accident or collision in lock

Other Conditions
- W – Collision or accident

LPMS Reason Codes

Lock Conditions

- EE – Repairing lock or lock hardware
- R – Lock hardware or equipment malfunction
- T – Maintaining lock or lock equipment
- Y – Inspection or testing lock

ERDC

Questions ???